FORE / AFT DYNAMICS AND PERFORMANCE IN SLALOM

Håvard Tjørhom[1], Robert Reid[1], Tron Moger[1], Per Haugen[1], Matthias Gilgien[1], Ronald Kipp[2], Gerald Smith[1]
1. Norwegian School of Sport Sciences, Oslo, Norway 2. University of Utah, USA

Introduction

While relative fore/aft motion between the skier and skis along the ski's longitudinal axis is a commonly acknowledged element of alpine skiing technique, there are differing opinions as to how much movement occurs and how important it is for performance (Figure 1). Although there exist numerous qualitative descriptions, few quantitative analyses of fore/aft dynamics have been published. The aim of this study was therefore to quantify the fore/aft dynamics of a group of highly-skilled athletes in slalom and to relate these measures to performance.

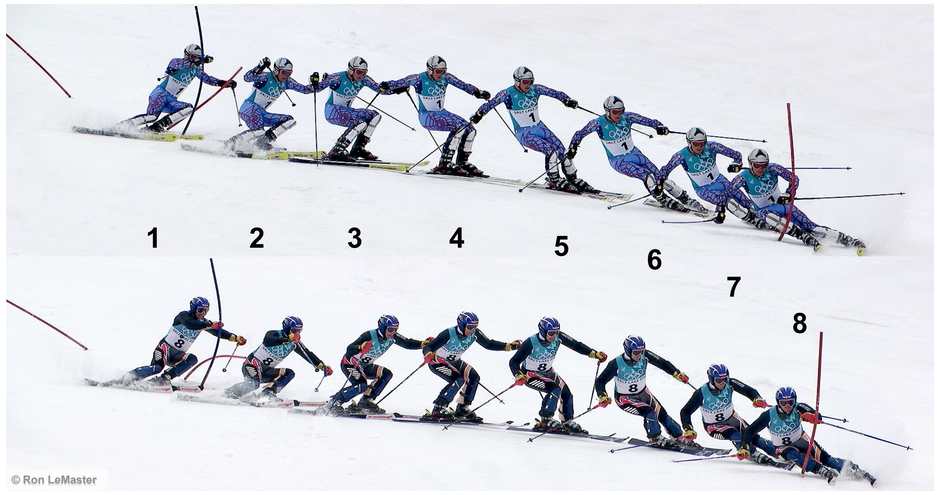

Figure 1. Two athletes demonstrating different approaches to fore/aft dynamics in their technique. Athlete A is thought to have a technique that involves a much greater degree of fore/aft motion than Athlete B. In particular, notice the differences in images 3 to 5.

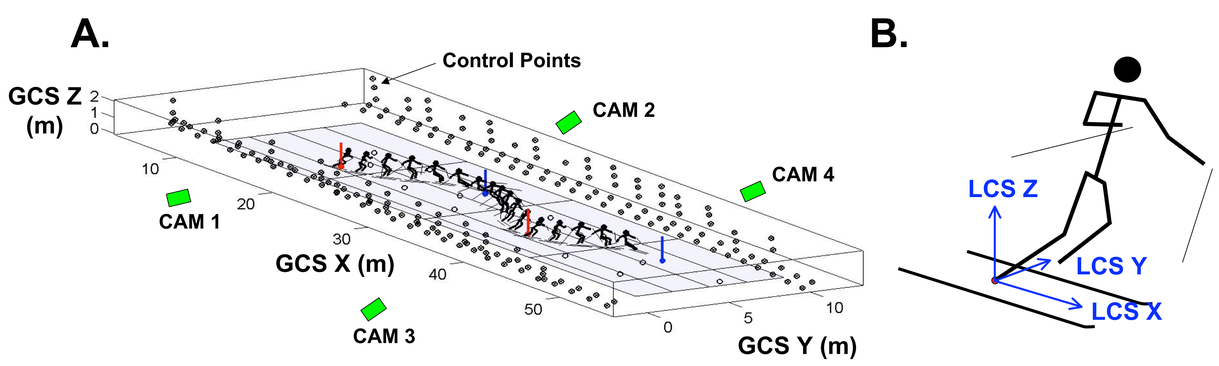

Figure 2. (A.) Experimental set-up indicating the global coordinate system (GCS), control points, camera positions, and gate positions. (B.) Definition of the outside ankle joint center local coordinate system (LCS).

Methods

The performances of 6 members of the Norwegian men's Europa Cup team were analyzed during a slalom race simulation. Skier 3-D positions were determined from 4 panning video cameras and calibration control points distributed near the course [1] (Figure 2A). A local coordinate system (LCS) originating at the outside ankle joint center was defined at each point in time [2] (Figure 2B).

The LCS axes were defined as being parallel and perpendicular to the longitudinal axis of the outside ski and normal to the plane of the snow surface (x, y, and z axes, respectively). Motion of the whole body center of mass (COM) in the local x-dimension was time-normalized to the turn cycle. Fore/aft range of motion (X_{ROM}), and average position in the local x-dimension (X_{AVG}), during a turn cycle were used to characterize the athlete's fore/aft movements. Partial correlation coefficients between X_{AVG}, X_{ROM}, and performance time were calculated while controlling for entrance velocity.

Results

Figure 3A shows the ensemble average COM position in the local x-dimension for the 6 athletes. The mean ± SD X_{ROM} and X_{AVG} during a turn cycle were 28.4 ± 3.6 cm and 3.9 ± 2.7 cm, respectively. Partial correlation coefficients for X_{ROM} and X_{AVG} with performance time were r = 0.76 and r = 0.98 (p = 0.003), respectively.

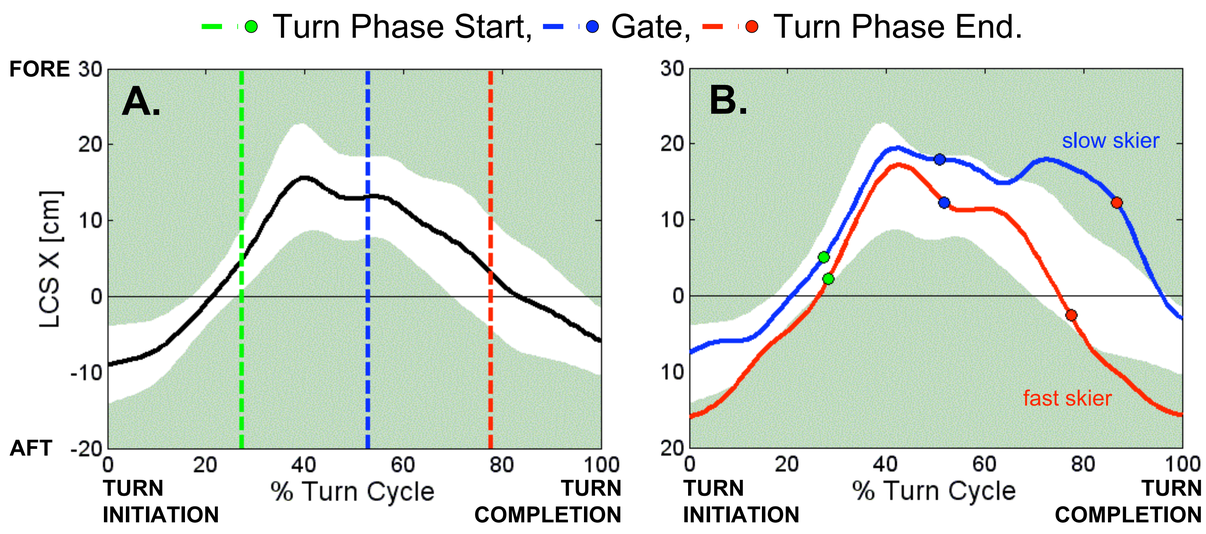

Figure 3. (A.) Ensemble average (±SD) of fore/aft position through a complete turn cycle. (B.) Two athletes' fore/aft position through the first analyzed turn. The solid blue and red lines indicate a slow and fast skier, respectively.

Discussion & Conclusions

This study has quantitatively described the fore/aft dynamics of a group of highly skilled skiers in slalom. In this study, the COM of slower skiers was positioned further forwards while that of faster skiers was positioned closer to the ski center. Although a weak relationship between X_{ROM} and performance was observed, a cyclic pattern in fore/aft dynamics is apparent (Figures 3A and 3B) and this pattern seems to be more consistent for the faster athletes.

References

[1] Nachbauer W *et al* (1996). J Appl Biomech, 12, 104-115.
[2] Schiefermüller C *et al* (2005). In E. Müller *et al* (Eds.) Science and Skiing III, Meyer & Meyer Sport, 172-185.

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